Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.38158

Magma Emplacement, Flow and Differentiation in a Structural Context: Basalt and Upper-Crust Mafic Intrusions, Central Atlantic Magmatic Province, Eastern North America (southeast Pennsylvania, USA)

LEEANN SROGI[1], MARTHA O. WITHJACK[2], TIM LUTZ[1], MEAGEN POLLOCK[3] AND ELIZABETH KARLEE FINCH[1]

[1]West Chester University
[2]Rutgers University
[3]The College of Wooster

The basalts and upper-crustal diabase (dolerite) sheets of the Central Atlantic Magmatic Province in Eastern North America (ENA-CAMP) are a natural volcanic-plutonic laboratory. The Adamstown-Morgantown-Jacksonwald (AMJ) intrusive complex (SE Pennsylvania, USA) developed during final stages of Pangaean rifting at ~201.5 Ma. We reconstructed the 3D geometry of the AMJ complex at the time of emplacement by integrating structural and petrologic data with lidar and aeromagnetic imagery. Intrusion morphologies and magmatic flow paths closely resemble those in 3D seismic studies and provide context for interpreting our geochemical and petrologic dataset. Textures, mineral and rock compositions and crystallization models (rhyolite-MELTs v.1.2.0) are used to investigate formation processes.

Some intrusion margins are virtually identical to the erupted basalt while others have slightly different compositions and crystal cargo indicating different magma batches. Phenocryst zoning patterns are consistent with rapid growth and magma mixing during the first 10-30% of crystallization in a dynamic open system at depth. Rapid cooling of rift basin intrusions is indicated by cryptocrystalline textures in upper contact samples and internal contacts/chills and is supported by 1-D conductive cooling models (with latent heat release).

An igneous stratigraphy defined in a nearly complete drill core transect can be traced across the Morgantown intrusion at similar positions (% distance from a contact) at different emplacement depths and distances from the feeder (~3 to ~20 km laterally, up to 7 km vertically). Pyroxene phenocrysts and crystal clusters were separated from liquid by gravitational and lateral flow during emplacement and accumulated in the lower third and upper fifth of the intrusion. Small plagioclase phenocrysts, mostly carried with the liquid, formed cm-scale plagioclase-pyroxene modal layering in ~90% of the intrusion. Macro- and microstructures and plagioclase zoning indicate layer formation by lateral, up-dip shear flow during emplacement, consistent with analog experiments. Evidence of crosscutting, post-emplacement, sub-vertical melt migration is widespread, from pervasive to channelized flow of mafic melts in crystal mush with ~30-55% liquid, to veins/lenses of coarse-grained, Fe-, Si- and water-rich rocks in the upper third of the intrusion that formed after ~50-80% crystallization. Nearly identical features occur in the other AMJ and correlative ENA-CAMP intrusions.